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TRANSFER OF CONTAMINANTS BETWEEN THE WATER COLUMN AND BOTTOM SEDIMENTS: THE ROLE OF DEPOSIT- AND SUSPENSION-FEEDING BENTHIC INVERTEBRATES

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LONG-TERM GOALS

The ultimate goal of this research is to determine the dominant mechanisms whereby and the rates at which fine particles (< 0.05 mm) are incorporated into marine sediments. Particular focus is on developing a mechanistic understanding of the role that deposit- and suspension-feeding benthic invertebrates play in particle deposition and burial relative to the abiotic case.

OBJECTIVES

The objectives of this project are to manipulate and test various combinations of hydrodynamic, sedimentological and biological parameters to determine the magnitude of: (1) net accumulation of fine particles in sandy and "reworked" (mixed grain size) sediments relative to muddy sediments, (2) biodeposition by suspension feeders relative to deposit feeders, and (3) vertical transport modes and rates of sediment within the bed by deposit feeders.

APPROACH

Carefully tailored laboratory flume and still-water experiments are used to quantify effects of suspension- and deposit-feeding benthic invertebrates on the transport of fine-grained sediment to the seabed, and its subsequent burial. Using organisms from a wide variety of functional and taxonomic groups, the flume studies involve a nested, experimental design with two flow regimes: (1) steady, supercritical flow (i.e., where there would not be any flat-bed deposition), and (2) unsteady (tidal) flow. For both flow regimes potential organism effects are being quantified relative to the abiotic case. A variety of techniques, including digital particle image velocimetry (DPIV), optical backscatter sensors, x-radiography and deliberate particle tracers, are used in the experiments.

Aspects of this research (e.g., DPIV, animal-tube mimic study) are being conducted by J. Steven Fries as part of his dissertation research in the MIT/WHOI Joint Program. Steve is beginning the third year of his graduate studies.

FY-97 WORK COMPLETED

One manuscript (Wheatcroft et al., 1998) was submitted, revised and accepted for publication. A second manuscript (Fries et al., 199X) has been submitted and is currently under review.

An extensive set of experiments involving animal-tube mimics were conducted in the Rinehart Coastal Research Center's 17-meter flume. In these experiments, near-bed velocity fields (u,w & u,v) and bottom stress were measured using DPIV. Multiple combinations of tube density (four levels spanning two orders of magnitude), height and diameter were studied.

A limited field study was conducted to assess whether a terebellid polychaete significantly increased the inventory of fine-grained sediment in a shallow subtidal sand environment.

An experiment examining density-dependent bioturbation by *Nephtys incisa* (an active burrowing polychaete) was initiated.

RESULTS

Research in the early 1980's (e.g., Eckman et al., 1981 and other later publications) explored the effects of animal tubes on sediment erosion and deposition patterns. They documented stress distributions around isolated animal-tube mimics, but due to severe logistical challenges did not extend these measurements to tube patches. Hence, wake interaction effects and the question of what density tube arrays shifted from stabilizing to destabilizing were unresolved. The goal of our tube experiments was to quantify the bottom stress distribution and vertical velocity field within tube patches of varying density and aspect ratio.

Preliminary analyses indicate horizontal and vertical velocity patterns within the tube arrays that build upon previous work. For example, at mean flow speeds of ~ 20 cm/s, vertical velocities below tube heights shifted from negative to positive (i.e., up) with increasing tube density. Positive near-bed vertical velocities may indicate that eddy impingement is prevented (i.e., the start of skimming flow). The interesting aspect of this result, is that this effect was observed at tube densities that are substantially lower than the stabilizing cutoff (e.g., Eckman et al., 1981). Further analyses are planned.

Previous lab experiments that we conducted with the terebellid polychaete, *Enoplobranchus sanguineus*, have demonstrated its capacity to nonlocally transport fine-grained sediment to depths of several centimeters in the seabed. A logical consequence of this activity is that areas supporting large numbers of terebellids should have a higher inventory of fine-grained sediments than areas without terebellids. Analyses to date, are consistent with this conjecture. There is roughly a factor of two more fines in the cores containing numerous terebellids, than those without terebellids.

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